

QP CODE: 23145522



Reg No : .....

Name : .....

**M Sc DEGREE (CSS) EXAMINATION, DECEMBER 2023**

**First Semester**

**CORE - CH500104 - THERMODYNAMICS, KINETIC THEORY AND STATISTICAL  
THERMODYNAMICS**

M Sc CHEMISTRY, M Sc ANALYTICAL CHEMISTRY, M Sc APPLIED CHEMISTRY, M Sc  
PHARMACEUTICAL CHEMISTRY, M Sc POLYMER CHEMISTRY

2019 ADMISSION ONWARDS

6E163C04

Time: 3 Hours

Weightage: 30

**Part A (Short Answer Questions)**

Answer any **eight** questions.

Weight **1** each.

1. What are partial molar quantities? Give examples.
2. Establish the dependence of fugacity on temperature.
3. What are excess thermodynamic functions? Give examples.
4. Draw the phase diagram of the three component system : NaCl-KCl- H<sub>2</sub>O at 15<sup>0</sup>C.
5. Define collision frequency. What is the effect of pressure on collision frequency?
6. Discuss the significance of Law of corresponding states.
7. What are the salient features of Boltzmann distribution statistics?
8. Arrange translational, rotational, vibrational partition functions based on their magnitude. Justify your answer.
9. What are Fermions? Give examples.
10. The characteristic Debye temperature of diamond is 1860 K. Calculate its heat capacity at 100 K.  
(8×1=8 weightage)

**Part B (Short Essay/Problems)**

Answer any **six** questions.

Weight **2** each.

11. Derive the thermodynamic equation of state  $(\partial E/\partial V)_T = T(\partial P/\partial V)_T - P$  and show that  $(\partial E/\partial V)_T = 0$  for an ideal gas.



12. Describe a method for determining absolute entropies using third law.
13. Derive the equation for average and RMS velocity.
14. (a) How is the third law of thermodynamics formulated from statistical thermodynamics? (b) Estimate the value of residual entropy of carbon monoxide.
15. Write a note on Bose-Einstein condensation.
16. For the reaction  $\frac{3}{2} \text{O}_2 \rightleftharpoons \text{O}_3$ , given that  $\Delta G^\circ$  of ozone is  $163 \text{ KJmol}^{-1}$ . Calculate  $K_p$  and  $K_c$  at  $25^\circ\text{C}$  and 1 atm pressure.
17. Calculate the temperatures at which the RMS, average and most probable velocities of oxygen gas are all equal to  $1500 \text{ ms}^{-1}$ .
18. Calculate the rotational partition function for Hydrogen molecule at 300 K, moment of inertia of hydrogen molecule is  $4.59 \times 10^{-47} \text{ kgm}^2$  and symmetry number,  $\sigma = 2$ .

(6×2=12 weightage)

### Part C (Essay Type Questions)

Answer any **two** questions.

Weight **5** each.

19. (a) Deduce Vant Hoff's reaction isochore and explain its significance. (b) Explain the effect of pressure on equilibrium constants  $K_p$ ,  $K_c$  and  $K_x$ .
20. The Maxwell Boltzmann distribution of molecular velocities gives an idea of distribution of molecular velocities. Derive an expression for the distribution. How is this distribution verified?
21. Write short notes on  
(a) Macrostates (b) Microstates (c) Equal-apriori principle (d) Phase - space (e) thermodynamic probability
22. (a) Discuss the quantum theory of heat capacities of gases. (b) Discuss the heat capacity of hydrogen gas with reference to quantum statistics. (c) What is residual entropy? Explain using an example

(2×5=10 weightage)